Marconi
Instruments

6910

RF POWER SENSOR

Instruction Manual

Instruction Manual

H 6910

RF POWER SENSOR

6910

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Note...

Each page bears the date of the original issue or the code number and date of the latest amendment (Am. 1, Am. 2 etc.). New or amended material of technical importance introduced by the latest amendment is indicated by triangles positioned thus ▶ ..... ◀ to show the extent of the change. When a chapter is reissued the triangles do not appear.

Any changes subsequent to the latest amendment state of the manual are included on inserted sheets coded C1, C2 etc.

HAZARD WARNING SYMBOLS

The symbols listed below appear on the equipment to indicate possible hazards to the equipment and/or the user.

Symbol	*Location*	*Reference in manual*	*Nature of hazard*
	Label on outer casing	Page (iv)	Precision type N connector. Do not mate with standard type N connectors.
	Engraved on front plate adjacent to RF assembly retaining screws	Page (iv)	Incorrect dismantling may cause irreparable damage. See Chap. 5 for dismantling instructions.
	Label on outer casing	Page (iv)	Unit contains static sensitive components. Avoid handling printed circuit board (PCB).

WARNINGS, CAUTIONS AND NOTES

For the purposes of this manual, the following definitions apply :

WARNING. Information relating to possible hazards to health or safety when operating or servicing the equipment.

CAUTION. Information relating to possible damage to the equipment when operating or servicing.

Note. Information of general importance.

WARNINGS, CAUTIONS and Notes of a general nature are given below.

WARNING : TOXIC HAZARD

Many of the electronic components used in this equipment employ resins and other chemicals which give off toxic fumes on incineration. Appropriate precautions should therefore be taken in the disposal of these items.

CAUTION : PRECISION CONNECTOR

The precision type N connector fitted to this sensor may be damaged by mating with general purpose type N connectors.

CAUTION : INCORRECT DISMANTLING

Incorrect dismantling may cause irreparable damage to some components. See Chap. 5 for dismantling instructions.

CAUTION : STATIC SENSITIVE COMPONENTS

Components identified with the symbol ⚠ on the circuit diagrams and/or parts lists are static sensitive devices. Certain handling precautions must be observed to prevent these components being permanently damaged by static charges or rapid charge surges.

(1) If a printed board containing static sensitive components is removed, it must be temporarily stored in a conductive plastic bag.

(2) If a static sensitive component is to be removed or replaced the following anti-static equipment must be used.

A work bench with an earthed conductive surface.

Metallic tools earthed either permanently or by repeated discharges.

A low-voltage earthed soldering iron.

An earthed wrist strap and a conductive earthed seat cover for the operator, whose outer clothing must not be of man-made fibre.

(3) As a general precaution, avoid touching the leads of a static sensitive component. When handling a new one, leave it in its conducting mount until it is required for use.

WARNING : HANDLING HAZARDS

Whilst every endeavour has been made to remove sharp points and edges, care should be taken, particularly when servicing the equipment, to avoid minor cuts.

Note : Compliance with Electrical Safety Standards.

This unit, when used with 6950 or 6960 RF Power Meter, is protected in accordance with IEC Safety Class 1. It has been designed and tested according to IEC Publication 148 'Safety Requirements for Electronic Measuring Apparatus', and has been supplied in a safe condition.

Note : Measurement Precautions.

(1) To prevent stray radiation being detected and displayed on the power meter, this sensor should be properly terminated in 50 Ω.

(2) Because the detection process involves the conversion of RF power to thermal power, time should be allowed for the sensor to take up the ambient temperature of the measuring environment before zeroing and operating the meter. Rapid temperature changes should be avoided while operating.

Chapter 1

GENERAL INFORMATION

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1 RF Power Sensor type 6910 1

FEATURES

1. The RF Power Sensor 6910 is used with Marconi Instruments RF Power Meters 6950 (analogue) and 6960 (digital). It provides the meter with an accurate chopped DC analogue of RF power over a 50 dB dynamic range from -30 dBm (1 μW) to +20 dBm (100 mW) at frequencies from 10 MHz to 20 GHz.

2. Each sensor is individually marked with a graph of 'calibration factor' and a 'linearity factor' figure. The appropriate calibration factor at the measurement frequency may be entered into both the 6950 and 6960 meters to enhance accuracy, and the linearity factor may also be entered into the 6960 to compensate for non-linearity at higher powers (preset in the 6950). A 'calibration data chart' which lists calibration and linearity factors to two decimal places is also provided with each sensor.

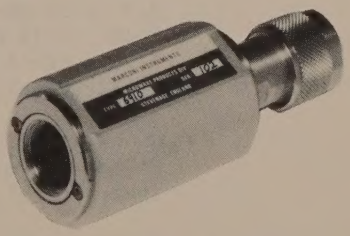

Fig. 1 RF Power Sensor type 6910

3. VSWR and uncertainty values are low across the entire frequency range of the sensor.

4. Zero drift due to temperature changes is less than 2.0 µW over the range 0°C to 60°C. Gain changes caused by fluctuations in ambient temperature are rapidly corrected by a compensating circuit.

5. The 6910 provides high level signals to the power meter so that the possibility of significant RF interference when measuring is negligible.

6. The 6910 is small, light and rugged in construction allowing it to be used confidently in bench or field applications without the need of any mechanical support.

7. High damage level minimizes the possibility of damage to the RF unit. Should this unit be damaged, however, it may be easily replaced by the user. See Chap. 5.

PERFORMANCE DATA

	Characteristic	*Performance*
8.	Power range :	-30 dBm (1 µW) to +20 dBm (100 mW).
	Maximum RF input :	+24.8 dBm (300 mW) average. Peak power 15 W for 2 µs.
	Frequency range :	10 MHz to 18 GHz, usable to 20 GHz.
	VSWR :	1.25 : 10-30 MHz, 1.1 : 30 MHz - 2 GHz, 1.18 : 2-16 GHz, 1.28 : 16-18 GHz, 1.4 (typical) : 18-20 GHz.
	Drift :	10 nW (typical, 1 hour after 24 hour warm-up at constant temperature).
	Linearity factor :	Provided with sensor.* Accuracy ±0.5% at 25°C.

Characteristic	*Performance*
Calibration factor :	Provided with sensor.
†RF connector :	Precision N-type male, 50 Ω.
Output connector :	Multiway. Mates with sensor cable assembly (supplied with power meter).
Size :	87 mm long (including connectors), 33.5 mm dia.
Weight :	140 g.

* Linearity factor is preset in 6950 and selectable in 6960.

† 6911 RF Power Sensor is available with the same specification but with an APC7 RF connector fitted.

Chapter 2

INSTALLATION

UNPACKING AND REPACKING

1. Retain the packing materials and the packing instruction note (if included) in case it is necessary to reship the sensor.

2. If the sensor is to be returned for servicing attach a label indicating the service required, type number, serial number and your return address.

3. If the original container or materials are not available use a strong double-wall carton packed with shock absorbing material around all sides of the sensor to hold it firmly.

Chapter 3

OPERATION

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1 With Power Meter 6950
6 With Power Meter 6960

With Power Meter 6950

Zeroing

1. Connect the 6910 to the SENSOR INPUT socket of the 6950 via the sensor cable supplied with the meter. With no power applied to the sensor, select the most sensitive range (RANGE switch fully anti-clockwise, -25 dBm position) and adjust the ZERO screw control for zero reading on the meter. A tool is provided for this purpose with the 6950.

Notes...

(1) If the sensor has been stored at a temperature different from that in the measurement environment, sufficient time should be allowed for thermal equilibrium to be established before zeroing or calibration.

(2) It may be helpful in setting zero to adjust the RESPONSE TIME control on the rear panel to reduce noise. It may also be found easier to set zero first on a less sensitive range, as slight adjustments of the ZERO control have considerable effect on the most sensitive range.

Calibration

2. Connect the 6910 to the POWER REFERENCE output of the 6950. Set the RANGE switch to 0 dBm. Set CAL FACTOR control to 100%. Switch on the POWER REF and set LIN F (linearity factor) to 50 Ω using the rear panel switches.

Adjust the front panel GAIN control for full-scale meter reading.

3. Turn off the power reference and disconnect the sensor from the output socket.

4. Determine the CAL FACTOR for the measurement frequency either from the sensor or the Calibration Data Chart. Set the CAL FACTOR control accordingly.

5. The power meter can now be used for measuring RF power. For full instructions and uncertainty calculations refer to the 6950 Operating Manual, Chap. 3.

With Power Meter 6960

Zeroing

6. Connect the 6910 to the SENSOR INPUT socket of the 6960, via the sensor cable supplied with the meter. With no power applied to the sensor, press [AUTO ZERO]. Five dashes will appear on the LCD, representing the meter's five power ranges. When the last of these has been removed from the LCD, all five ranges have been zeroed.

Note...

> If the sensor has been stored at a temperature different from that in the measuring environment, sufficient time should be allowed for thermal equilibrium to be established before zeroing or calibration.

Calibration

7. Press [LIN FACTOR] and enter the sensor's linearity factor.

8. Connect the 6910 to the POWER REFERENCE output of the 6960. Check that CAL FACTOR is set to 100%. Press [AUTO CAL]. The power reference LED comes on and 'CAL' is displayed on the LED. When calibration is completed, you can check that it has been successful by pressing [POWER REF].

This switches the power reference signal on, and 0 dBm should be displayed on the LCD.

9. Turn off the power reference and disconnect the sensor from the POWER REFERENCE output.

10. Enter the appropriate CAL FACTOR for the measurement frequency.

11. The meter can now be used for measuring RF power. For full instructions and uncertainty calculations refer to the 6960 Operating Manual, Chap. 3.

Chapter 4

TECHNICAL DESCRIPTION

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1 Overall circuit description
2 Detailed technical description
2 RF sensor
3 Signal chopper
5 Amplifier

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2 Simplified diagram of amplifier 2

OVERALL CIRCUIT DESCRIPTION - see Fig. 1

1. The RF SENSOR gives a small d.c. output voltage when power is applied. This d.c. voltage is converted to an a.c. signal by the SIGNAL CHOPPER. The chopped signal is fed to the AMPLIFIER which is divided into two parts, the first part being the power sensor and the other in the power meter. The signal is then processed by the power meter to give a power reading. A Zener diode in the power sensor provides sensor type information for the power meter.

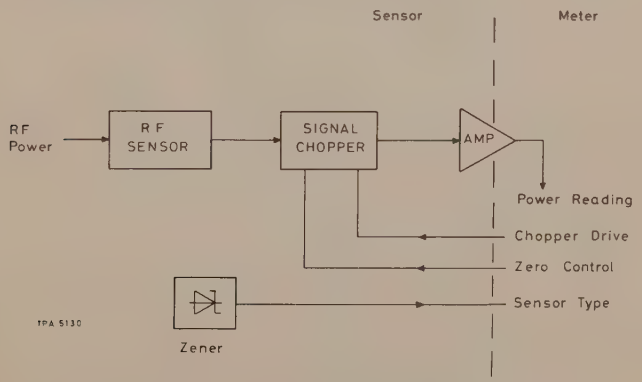

Fig. 1 Block diagram of r.f. power sensor

DETAILED DESCRIPTION *(Cct. diagram : Chap. 7, Fig. 1)*

RF sensor

2. The r.f. sensor consists of a monolithic semi-conductor thermocouple element. This element provides a good 50 Ω match to the r.f. power and an output voltage proportional to the r.f. power.

Signal chopper

3. The signal chopper consists of two field-effect transistors which act as a sampling gate. The sampling rate is controlled by a 925 Hz square wave signal from the power meter. The output of the signal chopper is a 925 Hz square wave with amplitude proportional to the r.f. input power.

4. A zero control signal from the power meter is introduced at the input of the signal chopper. This allows the power meter to cancel any residual output that occurs with no r.f. power applied.

Amplifier

5. The amplifier is divided between the power sensor and the power meter. A simplified circuit is shown in Fig. 2.

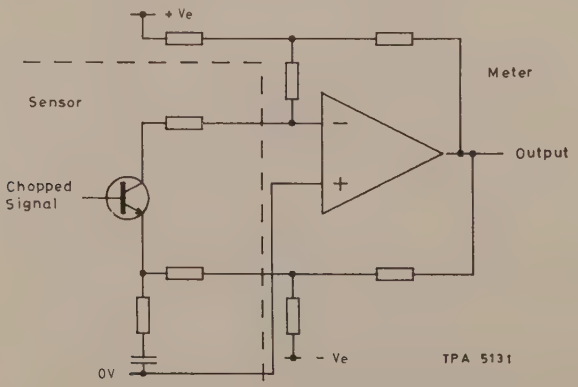

Fig. 2 Simplified diagram of amplifier

6. The amplifier has a gain of approximately 1000 and a band-pass characteristic centred at the sampling rate of 925 Hz. For a full description of the amplifier refer to the 6950 or 6960 Service Manuals.

7. A Zener diode is mounted in the sensor to provide head select information for the power meters. For 6910 type sensor head a 5.6 V diode is used.

Chapter 5

MAINTENANCE

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- Cautions
- Test equipment
1 Servicing policy and maintenance information
3 Faulty operation
4 Basic access
5 Fault finding
6 Testing the RF assembly
7 Testing the FET chopper assembly
8 Servicing
8 Replacement of RF assembly
9 Access to chopper/amplifier PCB

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1 Access and layout diagram 3

CAUTIONS

(1) It is important that the dismantling and re-assembling detailed in this chapter is performed in the order specified. This is because the gold wires which connect the RF assembly to the body assembly (see Fig. 1) are of extremely delicate construction and may easily be damaged if over-stressed. For this reason also, care should be taken when measuring voltages across or in the vicinity of the gold wires.

(2) Ensure that all parts are free from dirt, grease or moisture as these might impair the performance of the sensor.

TEST EQUIPMENT

Description	*Specification*
6950 or 6960 Power Meter	(with sensor lead)
Digital voltmeter	Resolution : 10 μV, : 1 Ω.
Power supply	Capable of producing ±5 V DC.
Allen key	1.5 mm.
Slot-head screwdriver	

SERVICING POLICY AND MAINTENANCE INFORMATION

1. For customer-servicing purposes, the sensor is considered in two parts (see Fig. 1).

(1) The RF assembly. This is not customer-servicable, but replacement RF assemblies may be quickly and easily fitted by the customer. See later in this chapter for testing and replacement instructions.

(2) The body assembly. This contains the PCB assembly on which the FET chopper and part of the amplifier are mounted. The procedure for testing the chopper is given later in this chapter.

The chopper is not customer-servicable but is available as a replacement part. The parts list in Chap. 6 and circuit diagram in Chap. 7 detail those components of the amplifier which are contained in the sensor. The remainder of the amplifier circuit is in the power meter, 6950 or 6960, and limited fault-finding information for this circuit is contained in the Service Manuals for these instruments.

2. The complete sensor may, of course, be returned to Marconi Instruments Service Division for repair (address at rear of manual).

FAULTY OPERATION

3. If the sensor is connected to a 6950 (or 6960) Power Meter and sensor lead which are known to be working, and either zeroing or calibration (as described in Chap. 3) cannot be successfully accomplished, then the sensor can be assumed to be faulty.

BASIC ACCESS

4. Remove the sensor cable from the 12 pin connector on the sensor. Remove the rear plate retaining screws (1) and (2) using a 1.5 mm allen key. Remove the rear plate and slide the casing from the sensor.

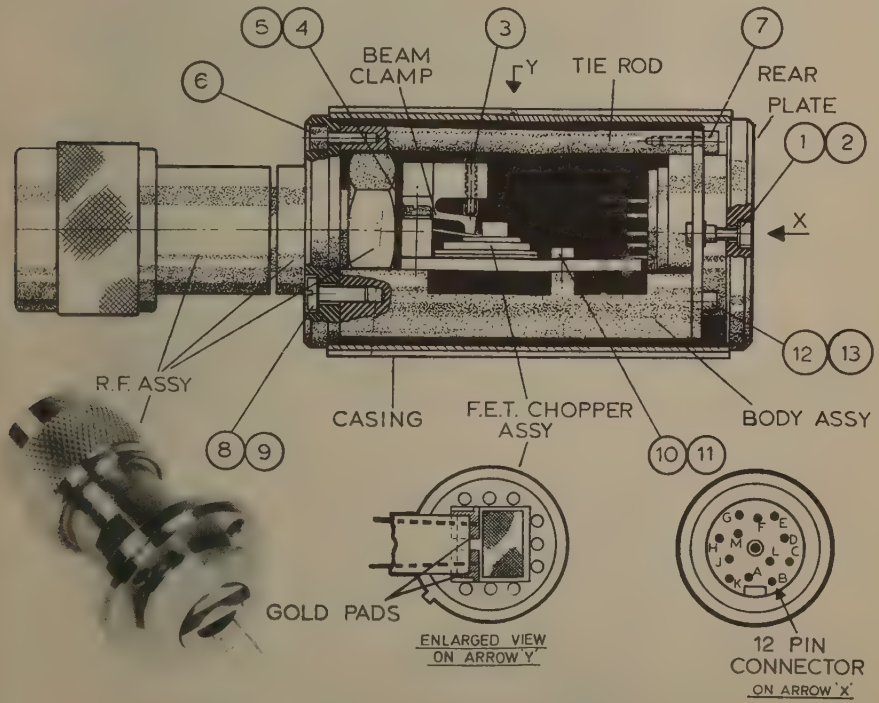

Fig. 1 Access and layout diagram

FAULT FINDING

5. Reconnect the sensor cable and power meter. Connect the input to the 1 mW 50 MHz reference output of the power meter. Switch on the reference signal.

Testing the RF assembly

6. (1) Carefully measure the voltage across the gold pads on the FET chopper assembly (see inset, Fig. 1).

(2) If the voltage is 100 µV or greater, the RF assembly is functioning correctly. In this case, test the FET chopper assembly as described in the next section.

(3) If the voltage is less than 100 µV, remove the sensor from the 1 mW reference. Remove the tie rod by removing screws ⑥ and ⑦ with the allen key. Remove the beam clamp, by first loosening the clamp screw ③, then removing the beam clamp fixing screws ④ and ⑤. Remove the beam clamp and carefully lift the two gold wires from the RF assembly clear of the gold pads.

(4) Reconnect the sensor to the 1 mW reference signal and carefully measure the voltage across the gold wires. If the voltage is now greater than 100 µV, it can be concluded that there is a fault on the chopper/amplifier PCB or in the 12 pin connector. If the voltage is still less than 100 µV, the RF assembly is faulty and must be replaced. See later section for replacement procedure.

Testing the FET chopper assembly

7. (1) Disconnect the sensor from the 1 mW reference and remove the sensor cable. Remove the beam clamp as described in step (3) of 'Testing the RF assembly'.

(2) Connect together sockets B, G and H of the 12 pin connector (see Fig. 1 inset) to turn both of the chopper's FETs on.

(3) Measure the resistance between the two gold pads. This should be approximately 100 - 200 Ω.

(4) Disconnect the link between sockets B/G and socket H. Apply -5 V to socket H. This will turn off the parallel FET of the chopper. The resistance measured across the gold pads should now be greater than 10 kΩ.

(5) Disconnect the link between sockets B and G. Connect socket H to socket B and apply -5 V to socket G. This will turn off the series FET of the chopper. The resistance measured across the gold pads should be greater than 10 kΩ.

If the applied signals are getting through to the FET chopper but any of the above measurements are not achieved then the assembly is faulty and should be replaced. See SERVICING section - Access to chopper/amplifier PCB.

SERVICING (see Fig. 1)

Replacement of RF assembly (code 6910-008)

8. (1) Dismantle sensor as described in BASIC ACCESS and FAULT FINDING, Testing the RF assembly, step (3).

(2) Carefully remove the two RF assembly fixing screws (8) and (9) using a screwdriver. Carefully separate the RF assembly from the body assembly without damaging the gold wires.

(3) Offer up the replacement RF assembly to the body assembly so that the fixing screw holes in the RF assembly flange match with those in the body assembly. Be careful not to damage the gold wires.

(4) Fit the fixing screws (8) and (9). Align the gold wires centrally over the gold pads on the chopper assembly.

(5) Ensure that the clamp screw (3) is not in contact with the lower part of the plastic clamp and fit the beam clamp in position using the fixing screws (4) and (5).

(6) Tighten the clamp screw (3) to firmly clamp the gold wires. The top of the clamp should just begin to bend upwards. If a torque screwdriver is available, tighten to 2 Ncm.

(7) Connect the partly assembled sensor to a power meter and check that zeroing and calibration can be successfully accomplished.

(8) Fit the tie rod in position using screws (6) and (7).

(9) Fit the casing and rear plate followed by the rear plate screws (1) and (2).

Access to chopper/amplifier PCB (chopper code 6910-004)

9. (1) Separate the RF assembly from the body assembly as described in steps (1) and (2) of Replacement of RF assembly.

(2) Remove the PCB fixing screws (10) and (11). Remove the 12 pin connector fixing screws (12) and (13). The PCB and 12 pin connector are now free of the body assembly.

(3) To replace the chopper/amplifier PCB and the 12 pin connector, reverse the above procedure.

Chapter 6

REPLACEABLE PARTS

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1 Abbreviations
2 Component values
4 Ordering
5 Components

ABBREVIATIONS

1. The components are listed in alphanumerical order of the complete circuit reference using abbreviations from the following list :

C : capacitor
Carb : carbon
Cer : ceramic
D : semiconductor diode
Elec : electrolytic
FS : fuse
IC : integrated circuit (package)
L : inductor
LP : lamp
Max : maximum
ME : meter
Met : metal
Mic : mica
Min : minimum
Ox : oxide
Pl : plug
Plas : plastic
R : resistor
S : switch
SK : socket
T : transformer
Tant : tantalum

TP : terminal
TR : transistor
Var : variable
W : watts at 70°C
WW : wirewound
† : value selected during test; nominal value listed
Ø : feedthrough component
 : static sensitive component

COMPONENT VALUES

2. One or more of the components fitted in this instrument may differ from those listed in this chapter for any of the following reasons :

(a) Components indicated by a † have their values selected during test to achieve particular performance limits.

(b) Owing to supply difficulties, components of different value or type may be substituted provided the overall performance of the instrument is maintained.

(c) As part of a policy of continuous development, components may be changed in value or type to obtain detail improvements in performance.

3. When their is a difference between the component fitted and the one listed, always use as a replacement the same type and value as found in the instrument.

ORDERING

4. When ordering replacements, address the order to the Technical Services Department of our Microwave Products Division (address on rear cover) or nearest agent and specify the following for each component required :

(1) Type and serial number of equipment.
(2) Circuit reference.
(3) Description.
(4) Part number.

COMPONENTS

"Prod" r-f.	Description	Manufacturer/ Part No.
	Power sensor, complete assy.	6910-001
	N type r.f. assy. replacement kit	6910-008
	Body assy. (includes Amplifier p.c.b. and Connector assy. SK1)	6910-002
	Connector assy, SK1	6910-052
	Amplifier p.c.b. assy.	6910-003
C1	Cer 0.01µF 20% 100V	ITT B111 MZ5U
C2	Tant 4.7µF 20% 50V	STC 39479A
C3	Tant 4.7µF 20% 6.3V	SPRAGUE 499D
C4	Tant 1µF 20% 35V	26486-209F
C5	Chip 100pF 10% 100V	STC 0805 FX7R
C6	Chip 100pF 10% 100V	STC 0805 FX7R
C7	Tant 2.2µF 20% 50V	STC 42310X
D1	Zener BZX79C5V6	28371-417X
R1	RES MF 348kΩ 0.5% 1/8W	HOLCO H8
R2	RES MO 330Ω 2% 1/8W	CORNING NK3
R3	RES MO 2.2kΩ 2% 1/8W	CORNING NK3
R4	RES MO 10kΩ 2% 1/8W	CORNING NK3
R5	RES WW 100Ω 2% 1/8W	6910-043
	FET Chopper assy. ⚠	6910-004
TR1	TRANS BC414	Motorola

Mechanical parts

Beam clamp	6910-048
Fixing screws (2 off)	21821-211W
Centre fixing screw (1 off)	21815-359X
Casing	6910-018
Rear plate	6910-019
Tie rod	6910-028

Chapter 7

CIRCUIT DIAGRAM

CONTENTS

Para.
1 Component values

Fig. Page
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1 Circuit diagram 3/4

Component values

1. The letter in the component value code replaces the decimal point and indicates the multiplier and unit as follows:-

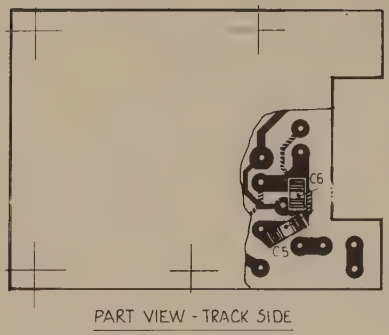
Resistors : Code letter R = ohms, k = kilohms (10^3),
M = megohms (10^6).

Capacitors : Code letter m = millifarads (10^{-3}),
μ = microfarads (10^{-6}),
n = nanofarads (10^{-9}),
p = picofarads (10^{-12}).

Inductors : Code letter H = henrys, m = millihenrys (10^{-3}),
μ = microhenrys (10^{-6}),
n = nanohenrys (10^{-9}).

* SIC : value selected during test, nominal value shown.

2. Components are marked normally with two, three or four figures according to the accuracy limit ±10%, ±1% or ±0.1%. Because a value 4m7 could be interpreted as 4.7 milliohoms, millifarads or millihenrys, each value on circuit diagrams is placed near to its related symbol.



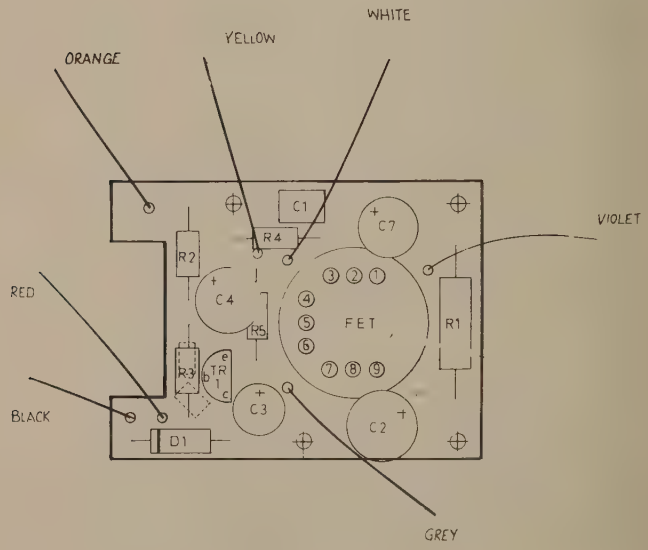
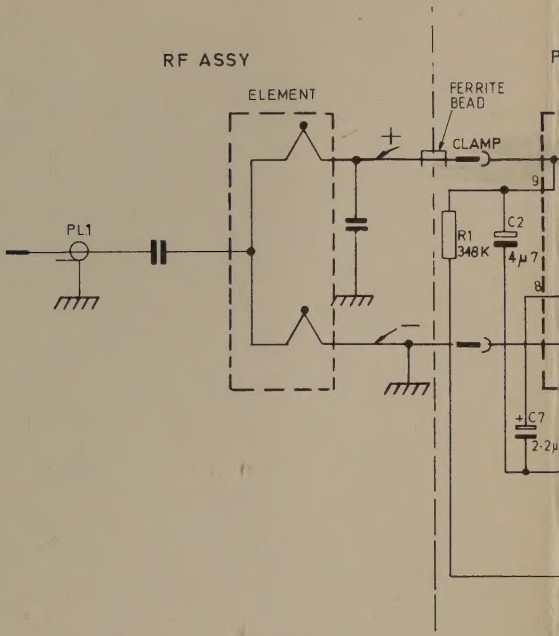
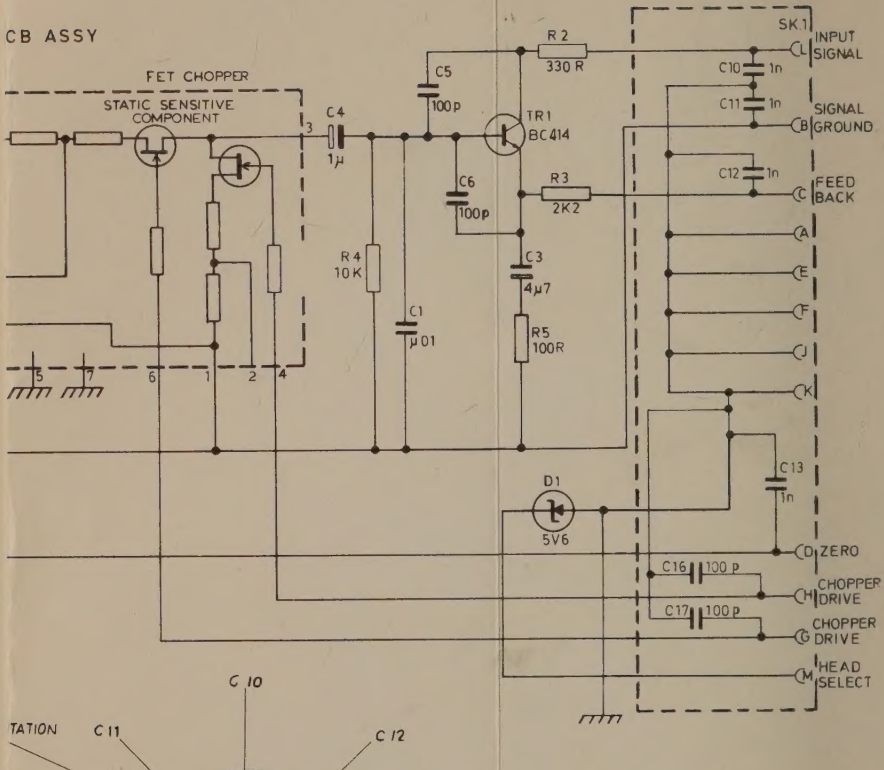


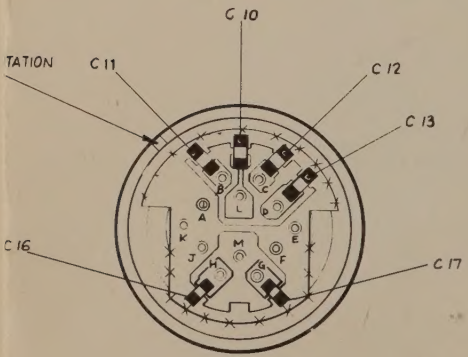
Fig. 1a Amplifier p.c.b. layout



FET CHOPPER
PIN LAYOUT

Fig. 1 Ci





CONNECTOR ASSY

rcuit diagram

6910

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